**INVESTIGATION OF AEOLIAN-RELEVANT PARAMETERS AT THE MESOSCALE FROM THE PRESENT TO 400KA.** Michaels[1], T.I., and Fenton[2], L.K. [1]Southwest Research Institute (Boulder, Colorado office; 1050 Walnut St Suite 300, Boulder, CO, 80516 USA; tmichael@boulder.swri.edu). [2]Carl Sagan Center (at the SETI Institute; 189 Bernardo Ave Suite 100, Mountain View, CA 94043 USA; lfenton@carlsagancenter.org).

**Introduction:** Within the last 400 thousand (Earth) years, Mars has almost certainly experienced a wide variety of insolation states (i.e., the seasonal and spatial distribution and magnitude of solar energy incident to the planet's atmosphere and surface). This is due to significant variations in orbital eccentricity, $L_s$ of perihelion, and (to a lesser extent) obliquity during that time interval. Insolation is the predominant source of energy that drives Mars' atmospheric circulations (directly or indirectly), and by association, aeolian surface modifications. A possibility then arises that a significant subset of the aeolian surface features/patterns seen today on Mars may not be billions or millions of years old, but instead may have been sculpted (perhaps from the "remains" of previous incarnations) during this more recent epoch.

**Motivations and Questions**: Meridiani Planum (Mars) plains ripples were last active possibly 50-200 ka, as interpreted from superposed craters [1] (see Figure 1). This tantalizing observational evidence and interpretation has resulted in more questions than answers – for example: During what climatic epoch(s) were these ripples last active? Why are they not active today, despite present-day sand transport near and among them? What sand flux magnitude would be required to (re)activate the ripples? What other aeolian surface features in Meridiani Planum may be relics of a past (recent) climate epoch?

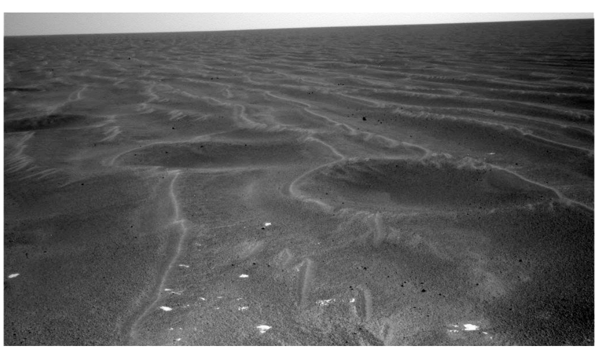

Figure 1: MER Opportunity Navcam image from sol 378, illustrating the Meridiani Planum aeolian ripples, along with some meter-class impact craters that have cut into them. These ripples are topped by millimeter-class fragments of the hematite spherules discovered by the MER Opportunity, which perhaps act as an effective armoring for the ripples in the contemporary era.

**Modeling Method**: Regional mesoscale atmospheric simulations are employed to investigate the impact of past (recent) insolation states on near-surface winds and air densities at spatial scales relevant to many aeolian surface processes. The regional mesoscale model used in this work is the Mars Regional Atmospheric Modeling System (MRAMS; [2,3]).

To provide the initial states and time-dependent boundary conditions for the MRAMS simulations, a suite of global climate model (GCM) simulation were performed using the NASA-Ames Mars GCM (v2.1) [4]. This version of the GCM utilizes a 5x6 degree horizontal latitude-longitude grid, a full water cycle, and TES-based atmospheric dust loading. The set of four insolation states used by Fenton and Michaels [5] was adopted for this preliminary work in order to produce complementary results. Each insolation case was represented by a 6 Mars-year GCM run, with instantaneous fields output every 1.5 Mars-hours. Insolation cases A through D, with axial obliquity, orbital eccentricity, and $L_s$ of perihelion listed:

Case A: 25.19º, 0.0933, 251.04º
Case B: 23.05º, 0.1089, 4.601º
Case C: 24.49º, 0.1177, 98.38º
Case D: 23.18º, 0.1117, 179.13º

For each insolation state, MRAMS simulations sampling all four seasons ($L_s$ ~ 30º, 120º, 210º, 300º) were conducted. Each of these mesoscale runs was several Mars-days in duration, and employed a finest grid-spacing of ~5.5 km over an area with dimensions of more than 600 km x 600 km. This highest-resolution grid is roughly centered on the MER Opportunity landing site. Chryse Planitia lies off to the northwest, and Hellas lurks to the southeast – but mostly, this region is a vast plain pockmarked by craters large and small. Endeavour Crater, the current location of the MER Opportunity, is just barely resolved by this grid (~4 grid-points in each coordinate direction). Instantaneous relevant MRAMS fields were output every 20 Mars-minutes for further analysis.

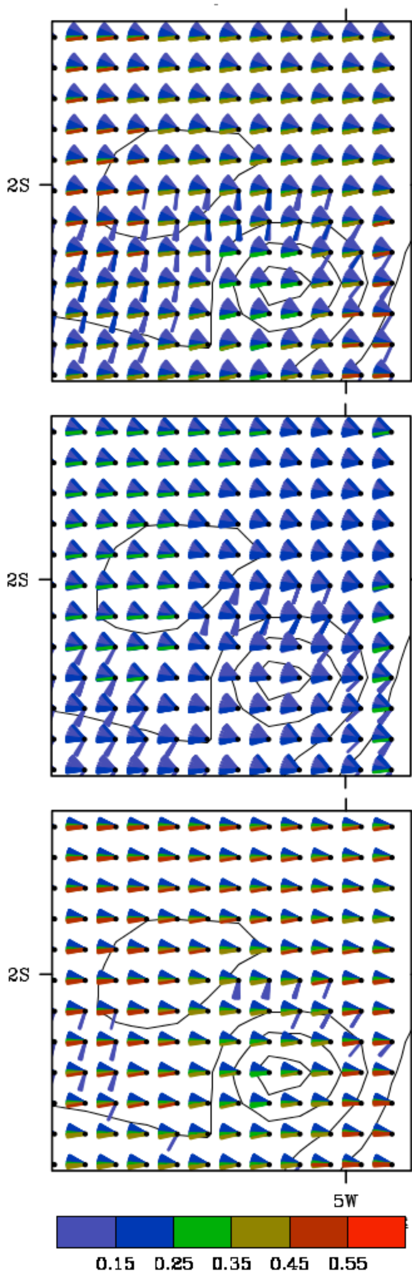


Figure 2: MRAMS results for Cases A (top), C (middle), and D (bottom) at $L_s$~300º. Contours are model topography (Endeavour crater, lower right). Color bar is $\tau/\tau_{init}$ . Colored segments show the direction (pointing downwind) of winds with $\tau/\tau_{init} > 0.1$ during one sol.

**Analysis Method:** This investigation is primarily focused on how the capacity of the wind to saltate sand may have varied in the recent past. As such, surface aerodynamic shear stress and its saltation thresholds are particularly relevant parameters, taking into account air density, wind speed, surface roughness, and particle density (among other things).

Surface aerodynamic shear stress (tau; $\tau$) is a measure of the stress (pressure) exerted horizontally by the atmosphere on surface elements. To *initiate* saltation of sand-sized particles there is thought to be a threshold function ($\tau_{init}$), that must be exceeded [6]. However, recent numerical work [7] for Mars has suggested that to *maintain* saltation once it has begun in a locale, only a much lower threshold function ($\tau_{main} \sim 0.1*\tau_{init}$) must be exceeded.

A convenient metric for aeolian processes is $\tau/\tau_{init}$ . Theoretically on Mars, saltation should initiate if this ratio is $\geq 1$, and saltation can be maintained if it is $\geq 0.1$ or so. Even when/where mean winds (i.e., those explicitly resolved by the mesoscale model) result in $\tau/\tau_{init}$ less than unity, subgrid-scale phenomena may still (in reality) be capable of initiating saltation. Such phenomena include turbulent gusts and dust devils. [8] explored daytime turbulent gusts on Mars and imply that even when the most intense turbulent gusts still have $\tau/\tau_{init} \sim 1$, the mean-wind $\tau/\tau_{init}$ may be 0.5 or lower.

**Preliminary Results**: The GCM results are quite similar to those discussed in Fenton and Michaels [5]. Thus far in the portion of Meridiani Planum examined, the maximum magnitude of modeled mesoscale (mean-wind) $\tau/\tau_{init}$ for the non-contemporary insolation states have differed only modestly (approximately -50%, +25%) from that of the contemporary mesoscale Mars run. It is probable that even the higher end of this range is insufficient to activate the ripples with their coarse-grained armor (see Figure 1). However, more study is needed of such ripples (perhaps using Mars-analogs on Earth) to quantitatively determine/estimate the sand flux threshold that is required to (re)activate them.

Still, some tangible mesoscale wind changes in this region are indicated for the insolation states examined thus far (see Figure 2) – including strong seasonal and diurnal variations. For example, strong wind modulations (+/-) can occur near and within craters not well-resolved in these simulation (see [9]). Nevertheless, there remains significantly more insolation state parameter space to investigate (within 400 ka), and other difficult-to-simulate phenomena such as dust storms may play a significant role as well.

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